Appendix F

National Resource Conservation Service (NRCS) Interim Practice Standards

Contents:

A National Interim Standard, Covered Anaerobic Lagoon (360), was issued in July of 1996. However, due to a change in national NRCS policy, Interim National Standards will be eliminated and that standard will be converted to National Guidance provided to States. Guidance for the development of standards for a Complete Mix Digester (364i) and a Plug Flow Digester (363i), included here, have been issued to State NRCS offices. NRCS personnel may then develop a State interim standard utilizing that guidance.

Appendix F National Resource Conservation Service (NRCS) Interim Practice Standards

METHANE PRODUCTION AND RECOVERY -
COVERED ANAEROBIC LAGOON
(NO.)
CODE 360

DEFINITION:

A constant volume lagoon designed for methane production and recovery in conjunction with a separate waste storage facility.

PURPOSE:

To produce and recover methane as an energy source while minimizing lagoon odors.

CONDITIONS WHERE PRACTICE APPLIES:

(1) where methane production and recovery are components of a planned livestock waste management system.

(2) where existing waste impoundment(s) can be modified to the requirements of this standard or for new construction.

(3) where the total solids (TS) concentration in the influent waste is less than 2%.

CRITERIA:

General Criteria:

Separation of Ruminant Manure Solids. Solids shall be separated from ruminant manures prior to entry into the lagoon.

Contaminated Rainfall Runoff. Manure-contaminated runoff shall bypass the covered methane production lagoon to the waste storage facility. Uncontaminated runoff shall not enter either the methane production lagoon or waste storage facility.

Lagoon. The lagoon shall meet the criteria for an anaerobic lagoon contained in Practice Standard 359, Waste Treatment Lagoon, with the following additional requirements:

(1) Design Operating Volume. The design operating volume shall be based either on the daily volatile solids (VS) loading rate per 1,000 ft^3, or the minimum hydraulic retention time (HRT) adequate for methane production, whichever is greater. The maximum daily VS loading rate shall be selected from the values listed on the map in Figure 1. The minimum HRT shall be selected from values listed on the map in Figure 2.

(2) Length to Width Ratio. The ratio of the length to the width of the lagoon is limited to 4:1 or less.

(3) Operating Depth. The operating depth of the lagoon shall be 12 feet or greater.

(4) Embankment Interior Slope. The embankment interior slope ratio (horizontal:vertical) shall be as steep as possible, 1:1 or greater as required by soil properties or construction techniques.

(5) Location of Inlet and Outlet. The inlet and outlet devices shall be located as far apart as practical to minimize “short circuiting”.

(6) Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, and freeze damage, incorporating erosion protection as necessary. Inlets from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings or other confined spaces. Inlets emptying above the surface

of the lagoon shall not be covered by the methane recovery cover.

(7) Outlet. The lagoon shall be equipped with an outflow device that will maintain the lagoon water surface at its operating level and release directly to the waste storage facility.

(8) Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Waste Storage Facility. The waste storage facility shall meet the requirements of Practice Standard XXX, Waste Storage Facility. No storage credit shall be attributed to the lagoon in meeting both minimum storage requirements and Practice Standard XXX.

Lagoon Cover. The cover materials and all appurtenances such as weights, floats, and attachments shall be designed to capture and convey the methane to a designed outlet. The cover shall also collect and direct precipitation to a designed gas outlet while exposed to site climatic conditions for its design life.

Safety. If the lagoons or methane recovery system will create a safety hazard they shall be fenced and warning signs posted to prevent children and others from using it for purposes other than intended.

Regulatory. Local, state, and federal laws shall be reviewed and complied with; there may be regulations that affect animal population, distance separations, storage volumes, storage periods, land requirements for nutrient application, fencing, or visual screening in excess of recommendations contained herein.

CONSIDERATIONS:

Location. Location of the waste storage facility should consider elevation and distance from the lagoon to take advantage of gravity flow.

The covered lagoon should be located as near the source of manure as practicable and as far from neighboring dwellings or public areas (minimum distance of 91 m (300 ft)) as possible; proper location should consider slope, distance of manure transmission, vehicle access, wind direction, neighboring dwellings, proximity of streams and floodplains, and visibility.

The covered lagoon should be located near a suitable site for energy utilization equipment. Short distances for the transmission of methane through buried pipe are preferable.

Visual Screening. Vegetative screens or other methods should be used to shield the lagoons from public view and to improve conditions.

Rainfall and Runoff. Uncontaminated runoff should not be introduced into the covered lagoon. Contaminated runoff should bypass the covered lagoon to the storage facility. Incident rainfall on the covered lagoon may be drained into the lagoon or pumped off the lagoon cover to a drainage structure.

Lagoon Depth. The lagoon shall be as deep as possible to maximize methane production and minimize the lagoon cover size.

Cover Material. Capital cost, repair technique, and warranty life should be considered when selecting a cover.

Cover Design. A variety of lagoon cover designs can be considered to meet the needs of the farm to collect and store incident rainwater or to exclude rainfall accumulation from the lagoons. The cover can either direct rainfall to one edge of the lagoon, drain rainfall into the lagoon, or prevent rainfall from entering the lagoon by accumulating rainfall and pumping it to rainfall discharge structures.

Cover Attachment. The cover can be attached to one or all embankments or float tethered to the embankments depending upon the cover design.

Appendix F National Resource Conservation Service (NRCS) Interim Practice Standards

PLANS AND SPECIFICATIONS:

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying this practice to achieve its intended use.

Cover. The cover manufacturer shall warrant the cover for the intended use and design life, provide maintenance instructions, and certify that the cover is properly installed.

OPERATION AND MAINTENANCE:

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The plan shall contain operation and maintenance requirements including but not limited to:

(1) Proper loading rate of the lagoon.
(2) Proper operating level of the lagoon.
(3) Estimates of methane production and recovery.
(4) Identification of a plan for safe use or flaring of biogas.
(5) Cover and other component maintenance.

Figure 1: Covered Anaerobic Lagoon Maximum Loading Rate (lb VS/1000ft^3/day)

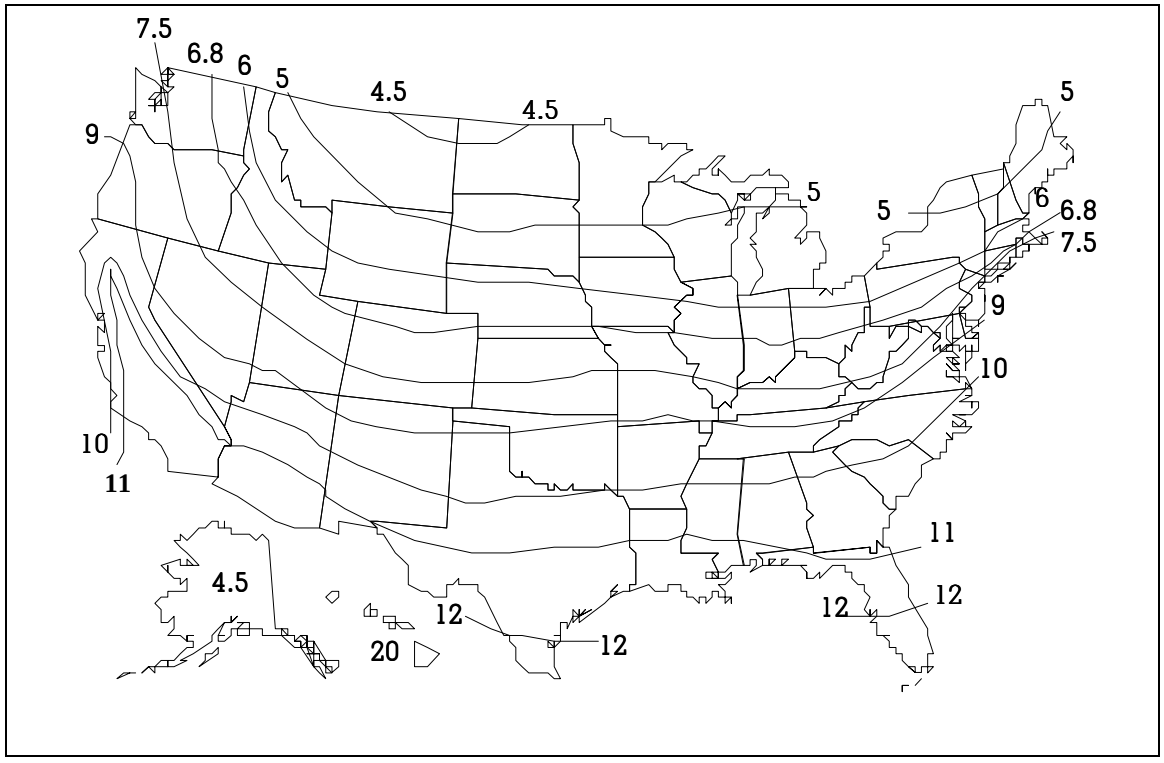

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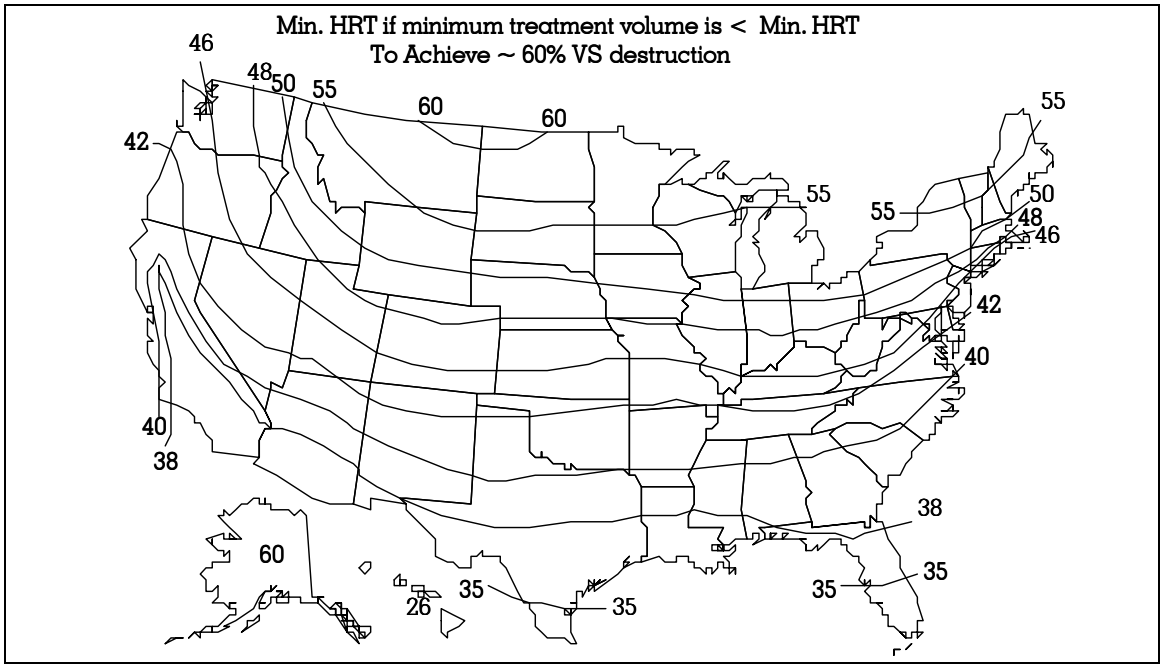
Figure 2: Covered Anaerobic Lagoon Minimum Hydraulic Retention Times (MINHRT)



NATURAL RESOURCES CONSERVATION SERVICE
INTERIM CONSERVATION PRACTICE STANDARD GUIDANCE

METHANE PRODUCTION AND RECOVERY - COMPLETE MIX DIGESTER (NO.) CODE 364-I

DEFINITION

A constant volume, flow through, controlled temperature tank designed for methane production and recovery in conjunction with a separate waste storage facility at a livestock production operation with manure of suitable consistency for this process.

PURPOSE

To produce and recover methane as an energy source while minimizing odors.

CONDITIONS WHERE PRACTICE APPLIES

(1) where manure is collected from concrete surfaces weekly or more often.

(2) where methane production and recovery are components of a planned livestock waste management system.

(3) where existing waste impoundment(s) can be modified to the requirements of this standard or for new construction.

(4) where the influent manure can be collected and delivered to the complete mix digester with a total solids (TS) concentration between 2.5% and 10%.

CRITERIA

General Criteria:

Manure Characteristics. This practice is applicable only to manures that are collected fresh, less than 7 days old, with minimal amounts of soil, sand, stones or organic bedding material. Clumps of long straw should be excluded and managed separately.

Total Solids Concentration. Manure influent to the complete mix digester shall contain 2.5 -10% total solids. Water or wastewater, other than needed for dilution to achieve design total solids concentration, shall be excluded.

Rainfall Runoff. Runoff water, clean or contaminated, shall not be allowed to enter the digester.

Safety. If the complete mix digester will create a safety hazard it shall be fenced and warning signs posted to prevent children and others from using it for purposes other than intended.

Regulatory. Local, state and federal laws shall be complied with; there may be regulations that affect animal population, distance separations, storage volumes, storage periods, land requirements for nutrient application, fencing, or visual screening in excess of recommendations contained herein.

Digester Criteria

Tank Characteristics. The complete mix digester tank shall be corrosion protected metal or reinforced concrete, above or below ground, with allowances for manure entry and exit, heat pipe entry and exit, and special consideration for solid concrete covers or attachment of secured, inflatable covers. Structural digester components shall meet the criteria of Practice Standard 313, Waste Storage Facility, and the following:

(1) Design Operating Volume. A complete mix digester shall be sized to retain 15 - 20 days of manure production and water as needed for dilution.

(2) Configuration. The complete mix digester may be a square, rectangular or circular tank.

(3) Operating Depth. The operating depth of a complete mix digester shall be 8 feet or greater.

(4) Floor. The complete mix digester floor may be conical or flat.

(5) Temperature Control. The tank shall be equipped with a heat exchanger designed to maintain the digester at the operating temperature. The heat exchanger within the digester shall be black iron, steel, copper, or aluminum (Galvanized iron will not per permitted) located below the normal operating fluid level.

Tanks shall be equipped with temperature sensors for monitoring internal temperature.

The tank surface, walls, and floor shall be insulated as required by local climatic conditions to reduce heat loss and maintain the design operating temperature. Each completed design shall include a summary of the heat balance computations for the heat exchanger and the digester tank at design operating conditions for the mean low winter and mean high summer temperatures.

(6) Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and prevent gas loss. The inlet shall enter the complete mix digester below the permanent liquid level.

(7) Outlet. The complete mix digester shall be equipped with an outflow device such as an underflow weir, that will maintain the operating level, maintain a gas seal under the cover, prevent gas loss, and release effluent directly to separation facility or waste storage facility.

(8) Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Mixing. The digester shall be equipped with a mixing device that is capable of breaking up floating solids or mats that may develop and suspend settled solids on a daily or more frequent basis.

Operating Temperature. The digester shall be maintained between 35^{o} and 40^{o} C (95^{o}-103^{o} F) with an optimum of 37.5^{o} C (100^{o} F) and daily fluctuation of digester temperature limited to less than 0.5^{o} C (1^{o} F). Special circumstances may allow higher operating temperatures.

Operating Level. The minimum distance provided between the maximum operating level and the top of the digester wall for complete mix digesters shall be as follows:

floating or inflatable tops.....6 inches
solid top .....18 inches

Cover. The cover shall be designed to capture and convey the methane to a designed gas outlet. The cover shall also collect and direct precipitation to a designed outlet while exposed to site climatic conditions for its design life. Capital cost, repair technique, and warranty life should be considered when selecting a cover.

Gas Outlet. A digester gas outlet shall be installed to safely convey biogas to its intended use or to a flare where it can be safely burned.

Weather Protection. In areas of extreme wind or excessive snow, appropriate structures may be necessary to protect a secured inflatable digester cover from damage.

Waste Storage Facility. The waste storage facility shall meet the requirements of Practice Standard 313, Waste Storage Facility. The volume of the digester shall not be considered in determining the storage requirement of the waste storage facility.

CONSIDERATIONS

Location. The complete mix digester should be located as near the source of manure as practicable and as far from neighboring dwellings or public areas (minimum distance of 91 m (300 ft)) as possible; proper location should also consider slope, distance of manure transmission, vehicle access, wind direction, proximity of streams and floodplains, and visibility. The digester should be located near a suitable site for energy utilization equipment. Short distances for the transmission of methane through buried pipe are preferable. Location of the waste storage facility should consider elevation and distance

from the complete mix digester to take advantage of gravity flow.

Collection/Mix Tank. A collection/mix tank may be required to accumulate manure, settle foreign material and pretreat influent waste to the appropriate total solids concentration. A volume equal to two days of manure collection is recommended.

Location of Inlet and Outlet. The inlet and outlet devices shall be located as far apart as practical to minimize "short circuiting".

Total Solids Concentration. The influent total solids concentration should be 2.5 - 10%, but as high as practicable for the livestock production facility. Excessive water addition increases digester size and construction cost without increasing benefits.

Gas Collection Cover. Gas collection cover can be a floating cover, secured inflatable fabric cover or a solid cover.

Cover Design. A variety of digester cover designs can be considered to meet the needs of the farm. A secured, inflatable cover allows for 4 - 12 hours of biogas storage. A solid cover does not allow for biogas storage.

Insulation. A design heat loss calculation should be completed and certified by a competent designer. Four feet of earthen backfill to within 1 foot of the top of the digester will usually provide adequate insulation. In cold climates, the surface of the digester and a portion of the side walls may require additional insulation. Above ground digesters will require insulation.

Gas Utilization. The most beneficial use of the biogas energy must be investigated and selected. A complete mix digester may require up to 50% of the biogas heat value to maintain the design temperature in the winter in cold climates. Heat can be recovered in cooling water from internal combustion engines or must be produced for the digester.

Effluent Tank. An effluent tank to hold ruminant manure digester effluent for solids separation treatment may be considered due to the potential value of digested, separated solids for bedding, or soil amendment. Non-ruminant digester effluents contain only a minimal amount of recoverable solids.

Visual Screening. Vegetative screens or other methods should be used to shield the complete mix digester from public view and improve appearance.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying this practice to achieve its intended use.

Heating System. The complete mix digester heating system should be designed by a competent designer familiar with these systems. The completed drawings shall include a summary of the design parameters and performance limits for the heating system.

Mixing Equipment. The complete mix digester mixing equipment should be designed by a competent designer familiar with these systems. Supplier shall warrant the mixing equipment for the intended use.

Cover. The cover manufacturer shall warrant the cover for the intended use and design life, provide maintenance instructions, and certify that the cover is properly installed.

Gas Use. Complete mix digester gas use system should be designed by a competent designer familiar with this equipment. Supplier shall warrant the gas use equipment for the intended use.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The plan shall contain operation and maintenance requirements including but not limited to:

(1) Proper loading rate of the complete mix digester.
(2) Proper operating level of the complete mix digester.
(3) Digester temperature control.
(4) Estimates of methane production and recovery.
(5) Identification of a plan for safe use or flaring of biogas.
(6) Environmental considerations for handling/utilization of effluent.
(7) Cover and other component maintenance.

NATURAL RESOURCES CONSERVATION SERVICE
INTERIM CONSERVATION PRACTICE STANDARD GUIDANCE

METHANE PRODUCTION AND RECOVERY - PLUG FLOW DIGESTER (NO.) CODE 363-I

DEFINITION

A constant volume, flow through, controlled temperature tank designed for methane production and recovery in conjunction with a separate waste storage facility at a livestock production operation with manure of suitable consistency for this process.

PURPOSE

To produce and recover methane as an energy source while minimizing odors.

CONDITIONS WHERE PRACTICE APPLIES

(1) where ruminant manure is scrape collected from concrete surfaces weekly or more often.

(2) where methane production and recovery are components of a planned livestock waste management system.

(3) where existing waste impoundment(s) can be modified to the requirements of this standard or for new construction.

(4) where the influent manure can be collected and delivered to the plug flow digester with a total solids (TS) concentration between 11% and 14%.

CRITERIA

General Criteria:

Manure Characteristics This practice is applicable only to ruminant manures that are collected by solid scraping equipment. Manure should be fresh, less than 7 days old, with minimal amounts of soil, sand, stones or organic bedding material. Clumps of long straw should be excluded and managed separately.

Total Solids Concentration. Manure influent to the plug flow digester shall contain 11-14% total solids. Water or wastewater, other than needed for dilution to achieve design total solids concentration, shall be excluded.

Rainfall Runoff. Runoff water, clean or contaminated, shall not be allowed to enter the digester.

Safety. If the plug flow digester will create a safety hazard it shall be fenced and warning signs posted to prevent children and others from using it for purposes other than intended.

Regulatory. Local, state and federal laws shall be complied with; there may be regulations that affect animal population, distance separations, storage volumes, storage periods, land requirements for nutrient application, fencing, or visual screening in excess of recommendations contained herein.

Digester Criteria

Tank Characteristics. The plug flow digester tank shall be corrosion protected metal or reinforced concrete, above or below ground, with allowances for manure entry and exit, heat pipe entry and exit, and special consideration for solid concrete covers or attachment of secured, inflatable covers. Structural digester components shall meet the criteria of Practice Standard 313, Waste Storage Facility, and the following:

(1) Design Operating Volume. A plug flow digester shall be sized to retain 18 - 20 days of manure production and water as needed for dilution.

(2) Configuration. The plug flow digester may be either a straight, flow through rectangular tank or, a rectangular or circular tank divided in half that forces flow down the tank, around the end of the center wall and back to an outlet. The ratio of the length to the width of a rectangular plug flow digester shall be between 3.5:1 and 5:1.

(3) Operating Depth. The operating depth of a plug flow digester shall be 8 feet or greater.

(4) Width to Depth. The ratio of the width to a depth of a plug flow digester shall be less than 2.5:1.

(5) Floor. The plug flow digester floor shall be flat.

(6) Temperature Control. The tank shall be equipped with a heat exchanger designed to maintain the digester at the operating temperature. The heat exchanger within the digester shall be black iron, steel, copper, or aluminum (Galvanized iron will not per permitted) located below the normal operating fluid level.

Tanks shall be equipped with temperature sensors for monitoring internal temperature.

The tank surface, walls, and floor shall be insulated as required by local climatic conditions to reduce heat loss and maintain the design operating temperature. Each completed design shall include a summary of the heat balance computations for the heat exchanger and the digester tank at design operating conditions for the mean low winter and mean high summer temperatures.

(7) Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and prevent gas loss. The inlet shall enter the plug flow digester below the permanent liquid level.

(8) Outlet. The plug flow digester shall be equipped with an outflow device such as an underflow weir, that will maintain the operating level, maintain a gas seal under the cover, prevent gas loss, and release effluent directly to separation facility or waste storage facility.

(9) Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Operating Temperature. The digester shall be maintained between 35^{o} and 40^{o} C (95^{o}-103^{o} F) with an optimum of 37.5^{o} C (100^{o} F) and daily fluctuation of digester temperature limited to less than 0.5^{o} C (1^{o} F). Special circumstances may allow higher operating temperatures.

Operating Level. The minimum distance provided between the maximum operating level and the top of the digester wall for plug flow digesters shall be as follows:

floating or inflatable tops.....6 inches
solid top.....18 inches

Cover. The cover shall be designed to capture and convey the methane to a designed gas outlet. The cover shall also collect and direct precipitation to a designed outlet while exposed to site climatic conditions for its design life. Capital cost, repair technique, and warranty life should be considered when selecting a cover.

Gas Outlet. A digester gas outlet shall be installed to safely convey biogas to its intended use or to a flare where it can be safely burned.

Weather Protection. In areas of extreme wind or excessive snow, appropriate structures may be necessary to protect a secured inflatable digester cover from damage.

Waste Storage Facility. The waste storage facility shall meet the requirements of Practice Standard 313, Waste Storage Facility. The volume of the digester shall not be considered in determining the storage requirement of the waste storage facility.

CONSIDERATIONS

Location. The plug flow digester should be located as near the source of manure as practicable and as far from neighboring dwellings or public areas (minimum distance of 91 m (300 ft)) as possible; proper location should also consider slope, distance of manure transmission, vehicle access, wind direction, proximity of streams and floodplains, and visibility.

The plug flow digester should be located near a suitable site for energy utilization equipment. Short distances for the transmission of methane through buried pipe are preferable. Location of the waste storage facility should consider elevation and distance from the plug flow digester to take advantage of gravity flow.

Collection/Mix Tank. A collection/mix tank may be required to accumulate manure, settle foreign material and pretreat influent waste to the appropriate total solids concentration. A volume equal to two days of manure collection is recommended.

Location of Inlet and Outlet. The inlet and outlet devices shall be located as far apart as practical to minimize "short circuiting".

Gas Collection Cover. Gas collection cover can be a floating cover, secured inflatable fabric cover or a solid cover.

Cover Design. A variety of digester cover designs can be considered to meet the needs of the farm. A secured, inflatable cover allows for 4 - 12 hours of biogas storage. A solid cover does not allow for biogas storage.

Insulation. A design heat loss calculation should be completed and certified by a competent designer. Four feet of earthen backfill to within 1 foot of the top of the digester will usually provide adequate insulation. In cold climates, the surface of the digester and a portion of the side walls may require additional insulation. Above ground digesters will require insulation.

Gas Utilization. The most beneficial use of the biogas energy must be investigated and selected. A plug flow digester may require up to 40% of the biogas heat value to maintain the design temperature in the winter in cold climates. Heat can be recovered in cooling water from internal combustion engines or must be produced for the digester.

Effluent Tank. An effluent tank to hold digester effluent for solids separation treatment may be considered due to the potential value of digested, separated solids for bedding, or soil amendment.

Visual Screening. Vegetative screens or other methods should be used to shield the plug flow digester from public view and improve appearance.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying this practice to achieve its intended use.

Heating System. The plug flow digester heating system should be designed by a competent designer familiar with these systems. The completed drawings shall include a summary of the design parameters and performance limits for the heating system.

Cover. The cover manufacturer shall warrant the cover for the intended use and design life, provide maintenance instructions, and certify that the cover is properly installed.

Gas Use. Plug flow gas use system should be designed by a competent designer familiar with this equipment. Supplier shall warrant the gas use equipment for the intended use.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The plan shall contain operation and maintenance requirements including but not limited to:

(1) Proper loading rate of the plug flow digester.

(2) Proper operating level of the plug flow digester.

(3) Digester temperature control.

(4) Estimates of methane production and recovery.

(5) Identification of a plan for safe use or flaring of biogas.

(6) Environmental considerations for handling/utilization of effluent.

(7) Cover and other component maintenance.